Vestibular Clinical Practice Recommendations

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Background. Dizziness is one of the most common reasons patients seek medical care from primary care providers, and the cause of dizziness is often related to the vestibular system (Kroenke and Mangelsdorrf, 1989). The incidence of dizziness and imbalance increases in two populations relevant to VA and military healthcare: older individuals and individuals who have suffered a head injury or blast exposure. Individuals who experience symptoms of dizziness and imbalance may undergo clinical bedside testing or testing with specialized instrumentation to quantify vestibular function (vestibular laboratory tests). Traditionally, vestibular laboratory tests determine vestibular function through the measurement of eye movement (vestibulo-ocular reflex or VOR) during stimulation of the horizontal semicircular canal function (hSCC) and through the evaluation of changes in body sway during static and dynamic balance tasks (postural control measures). More recently, tests have been developed to measure otolith organ function.

The role of the audiologist in the management of vestibular disorders has been well established and described in scope of practice and position statements for both the American Speech Language Hearing Association and the American Academy of Audiology (AAA, 2004, 2005; ASHA, 1999, 2006). Both organizations have advocated for the audiologist's role to include the assessment of vestibular function as well as treatment of vestibular disorders. Although audiologists are the primary healthcare professionals who perform vestibular laboratory tests, management of these patients may include several disciplines that provide diagnostic testing to determine etiology (e.g., audiology, otolaryngology, neurology, cardiology, psychology/ psychiatry) and rehabilitation services to address symptoms and impairments (e.g., physical therapy, occupational therapy, psychology/ psychiatry). With the exception of guidelines for evaluation and treatment of Benign Paroxysmal Positional Vertigo (BPPV), there are few clinical practice guidelines or recommendations available for healthcare providers who evaluate or treat individuals with dizziness or balance disorders.

Purpose. The vestibular working group was tasked by the VA Audiology Field Advisory Council to develop vestibular clinical practice recommendations for use by VA Audiologists. Members of the working group are listed above and include audiologists with clinical vestibular expertise from the Department of Veterans Affairs, the Department of Defense, and a university clinical setting.

Goals and Philosophy. The overall goal of the vestibular working group was to develop vestibular clinical practice recommendations that are (1) relevant to the majority of VA audiology clinics, and (2) applicable to the Veteran population. Therefore, the recommendations are focused on vestibular or balance tests that are used widely and most likely available to the majority of VA audiologists who practice vestibular assessment. Although the working group made several recommendations involving the use of advanced vestibular tests (e.g., computerized dynamic posturography, cervical VEMPs, and rotary chair), these recommendations were aimed at specific patient populations or symptoms (e.g., bilateral vestibular loss) and designed to supplement the basic vestibular test battery (e.g., videonystagmography). The vestibular clinical practice recommendations are not intended as a tutorial or as a sole source of guidance. The recommendations are intended to assist clinicians by providing an evidenced-based framework for decision-making strategies and it is not intended to replace clinical judgment.

Collaborating via teleconferences and email communication, the working group developed a working draft of recommendations for vestibular assessment and management of a patient presenting with or referred for assessment of dizziness and/or imbalance. A literature review was performed to determine the evidence base for Vestibular Clinical Practice Recommendations (see Appendix). Due to the wide scope of the recommendations and limited resources, the literature reviews were non-systematic and published systematic reviews and

guidelines were considered when available (e.g., Bhattacharyya et al.; 2008; Hillier and McDonnell, 2011).

The literature reviews for each recommendation were discussed among the members of the working group in a series of teleconferences, and the strength of the evidence was rated using the hierarchy summarized in Table 1. The group worked to reach consensus using the strength of evidence to support each recommendation. These vestibular clinical practice recommendations should be considered a living document, and updates and revisions should be incorporated as further evidence is published or clinical practices change.

Table 1. Strength of Evidence/Recommendation

Grade I	Evidence is strong and usually obtained from randomized controlled trials or well-designed clinical studies. The recommendation is usually indicated and accepted, and is considered effective and useful.
Grade II	Evidence is from clinical studies that were based on retrospective data analysis, clinical trials that were not randomized and/or carefully-controlled, or from panel consensus based on existing guidelines and practice patterns. The recommendation is accepted and the weight of evidence supports its use and effectiveness.
Grade III	Evidence is secondary in that it is based on current or long-standing practice without substantial supporting basic or clinical data. The recommendation is acceptable, but its necessity or usefulness may be questioned. The recommendation is made because it may be useful, and is not harmful.

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Vestibular Clinical Practice Recommendations

The strength of evidence and recommendation is indicated in parentheses following each vestibular clinical practice recommendation, and the current procedural terminology (CPT) code is indicated when applicable.

The recommendations assume that a patient is presenting with or referred for assessment of dizziness and/or imbalance.

1. Vestibular Case History. Obtain case history on patients with dizziness. Components of case history should include quality of symptoms, time course, exacerbating/relieving factors, associated factors, general medical history, and medication use (Grade II).
2. Quality of Life Questionnaires. Administer quality of life questionnaires or subjective questionnaires such as the Dizziness Handicap Inventory (DHI) to assess a patient's perceived handicap and limitations (Grade II).
3. Bedside Tests. The use of bedside tests is not recommended as a replacement for the videonystagmography/electronystagmography (VNG/ENG) test battery. The following bedside tests, however, may be used to complement the VNG/ENG test battery: modified Clinical Test of Sensory Interaction on Balance; The Romberg test; Valsalva Induced Nystagmus Testing; and Bedside (no goggles) Head Impulse Test. The usefulness of Fukuda stepping, vibration induced nystagmus, hyperventilation test, and head shake nystagmus test is less clear (Grade II).
4. Benign Paroxysmal Positional Vertigo (BPPV). Perform the Dix-Hallpike maneuver to rule out benign paroxysmal positional vertigo (BPPV) of the posterior or anterior semicircular canals (Grade I).
    a. If the Dix-Hallpike test is positive for posterior canalithiasis, then
        i. Treat with canalith repositioning procedure (modified Epley or Semont) (Grade I; CPT 95992).
        ii. Post-treatment restrictions are unnecessary (Grade II).
    b. If the Dix-Hallpike test is positive for anterior canalithiasis, then treat patient with canalith repositioning procedure (Grade II; CPT 95992).
    c. If the Dix-Hallpike test is negative, then perform the Roll test to rule out BPPV of the horizontal semicircular canal (Grade II)
        i. If BPPV is positive for horizontal canalithiasis, then counsel patient and treat with barbeque roll, Gufoni maneuver or forced prolonged positioning (Grade II; CPT 95992).
    d. If BPPV testing is positive and patient only complains of brief motion-provoked vertigo, then
        i. No further vestibular testing is necessary (Grade II).
        ii. Follow-up in 1-2 weeks with phone call or face-to-face visit (Grade II).

5. Videonystagmography/Electronystagmography (VNG/ENG). Perform VNG or ENG test battery

   (Use CPT 92540 Basic Vestibular Test Evaluation if spontaneous nystagmus with eccentric gaze fixation, positional nystagmus (minimum of 4 positions), optokinetic nystagmus test, and smooth pursuit were performed. Otherwise use individual codes listed below.)

   a. Perform otoscopy and/or tympanometry to rule out cerumen impaction or tympanic membrane perforation prior to testing (CPT 92567).

   b. At a minimum, the VNG/ENG test battery should include the following ocular motor tests: smooth pursuit (CPT 92545), saccade, eccentric gaze tests and search for spontaneous nystagmus (CPT 92541; Grade II).

   c. Testing may also include optokinetic nystagmus (CPT 92544), search for positional nystagmus (CPT 92542) and fixation suppression (Grade III).

   d. Perform the caloric test (air or water) to identify a horizontal semicircular canal/superior vestibular nerve lesion (CPT 92543 each irrigation; Grade II).

   e. Consider monothermal warm caloric screening when the following criteria exist: (1) total slow phase eye velocities for warm calorics > 11 degrees/sec, (2) no spontaneous or positional nystagmus, and (3) no ocular motor abnormalities. If the inter-ear difference for warm caloric screening is asymmetrical (> 10%) or if other criterion is not met, then bithermal calorics should be administered (CPT 92543 each irrigation; Grade II).

   f. If VNG/ENG test findings are normal, and

      i. Dizziness Handicap Inventory (or other quality of life questionnaire) indicates minimal balance handicap, then discharge patient back to referring provider (Grade III).

      ii. Dizziness Handicap Inventory (or other quality of life questionnaire) indicates significant balance handicap, then refer for balance and gait assessment (e.g., computerized dynamic posturography) including fall risk (Grade II).

   g. If VNG/ENG test findings indicate unilateral vestibular loss,

      i. then consider computerized dynamic posturography (CPT 92548; Grade II).

      ii. and the hearing evaluation indicates an asymmetric sensorineural hearing loss, then consider referral for auditory brainstem response (ABR) and/or magnetic resonance imaging (MRI) to rule out retrocochlear pathology. (Grade II).

      iii. then consider medical referral (e.g., otolaryngology, neurology) (Grade II).

      iv. and DHI (or other quality of life questionnaire) indicates significant balance handicap, then recommend vestibular rehabilitation (Grade I)

h. If VNG/ENG test findings indicate bilateral vestibular loss,
    i. then rule out the effect of medications (Grade II).
    ii. then perform or refer for rotational testing if available (CPT 92546; Grade II).
    iii. then consider computerized dynamic posturography if available (CPT 92548; Grade II).
    iv. then consider medical referral (e.g., otolaryngology, neurology) (Grade II).
    v. and patient reports significant symptoms of imbalance, then recommend vestibular rehabilitation (Grade II).

i. If the VNG/ENG test findings indicate ocular motor abnormalities,
    i. then rule out the effect of medications (Grade II).
    ii. then consider medical referral (e.g., neurology, ophthalmology) (Grade II).

6. Cervical Vestibular Evoked Myogenic Potentials (cVEMPs). Consider cervical vestibular evoked myogenic potentials in individuals with (CPT 92585):
    a. a history of dizziness or imbalance related to head trauma or blast exposure (Grade II).
    b. bilateral vestibular loss (Grade II).
    c. symptoms or audiometric findings consistent with superior semicircular canal dehiscence (Grade II).

7. Patient Counseling. Counsel patient regarding vestibular test findings (Grade III).

Appendix. Summary of the Literature Review for the Vestibular Clinical Practice Recommendations

Recommendation 1: Case History.

Obtain case history on patients with dizziness. Components of case history should include quality of symptoms, time course, exacerbating/relieving factors, associated factors, general medical history, and medication use.

Strength of Evidence/Recommendation: Grade II

Summary. A focused case history is standard practice in most audiology departments and for other medical providers serving patients with dizziness. The components of the case history provide a means to focus the examination of the patient. The literature related to case history in patients with dizziness and vertigo includes consensus articles, expert opinion, and retrospective data analysis. A few prospective studies have evaluated symptoms and two systematic reviews of dizziness symptoms are also available (Baloh, 1994, 1998; Bronstein, Lempert, Seemungal, 2010; Delaney, Delaney, 2003; Drachman, 1998; Drachman and Hart 1972, 1973; Drachman, Apfelbaum, Posner, 1979; Dros et al., 2011; Furman and Rizzolo, 2011; Halmalgyi, 2005; Hanley, O'Dowd and Considine, 2001; Hanley, 2002; Havia and Kentala, 2004; Isaacson and Rubin, 1999; Kentala and Rauch, 2003; Khattar and Hathiram, 2012; Newman-Toker et al., 2008; Stanton et al., 2007).

There are six components of a case history that are cited routinely in the literature as important for inclusion. (1) *Symptom description* is the first question asked during a case history. The patient's description of symptoms (i.e., vertigo vs. lightheadedness vs. pre-syncope vs. disequilibrium) is critical information that guides referral for appropriate clinical/laboratory assessment. This classification system was based on the seminal work of Drachman and Hart (1972) who described 4 types of symptoms and the likely corresponding etiology (vertigo: vestibular; presyncope: cardiovascular; lightheadedness/ill-defined dizziness: psychiatric/metabolic; and disequilibrium: neurological). (2) The *time course* for dizziness is an important aspect of the case history as it provides insight into potential causes of dizziness and whether dizziness may be of peripheral vestibular origin. Key aspects of the time course may include: (a) whether dizziness is episodic or constant, (b) duration of episodes, (c) frequency of the episodes, and (d) onset of symptoms. More recently, Stanton et al. (2007) re-iterated the importance of including time course of symptoms in the case history as they found that a patient's description of his/her symptoms were often unreliable and inconsistent. (3) Determining *provoking/relieving factors* and (4) *associated symptoms* during a history may provide additional information in terms of differential diagnosis and determining peripheral versus central origins. (5) *Relevant general medical health* may include vision loss, neck/back pain, migraines, diabetes, cardiovascular, falls history, walking with assistive device, recent onset of virus/cold, and neurological disease/stroke. (6) Finally, *medication/drug/alcohol use* that may affect test results (e.g., central nervous system (CNS) suppressants and/or vestibular suppressants) is important in interpretation of clinical findings.

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Recommendation 2. Quality of Life Questionnaires.

Administer quality of life questionnaires or subjective questionnaires such as the Dizziness Handicap Inventory (DHI) to assess a patient's perceived handicap and limitations.

Strength of Evidence/Recommendation: Grade II

Summary. Subjective scales have been administered to individuals with dizziness and imbalance for clinical use and research studies to assess quality of life. Few randomized controlled trials have been performed using subjective scales and the vast majority of studies have utilized retrospective chart reviews, cross-sectional studies, or results from panel consensus based on existing practice patterns and existing guidelines. The preponderance of evidence suggests that these scales do not correlate or predict findings on objective clinical vestibular assessments; and, therefore, are not useful as screening instruments for vestibular dysfunction (Jacobson et al., 1991; Perez et al., 2003). Subjective scales have correlated (to varying degrees) with functional measures of gait, balance, and falls prediction/risk, although the findings vary widely across subjective scales and studies. Subjective scales have been used to measure outcomes in individuals with dizziness (Krebs et al., 1993; Mruzek et al., 1995); therefore, expert opinions and existing guidelines suggest the usefulness of subjective scales is for counseling and outcome measures for rehabilitation. Listed below are summaries of several available subjective scales.

Dizziness Handicap Inventory (DHI). The DHI was developed to evaluate the subjective complaints of patients with dizziness, vertigo and/or imbalance (Jacobson and Newman, 1990). The 25-question scale is a measure of self-perceived disability/handicap in patients with dizziness. General consensus is that the DHI scale is useful in establishing perceived handicap for counseling purposes and measuring rehabilitative progress in therapy. Research on the DHI has produced mixed results relative to correlations to behavioral balance. In some studies, patients with higher DHI scores have shown greater functional impairment (Whitney, 2004, Vereeck et al., 2007, Perez, Martin, and Garcia-Tapia, 2003); whereas, other studies report no differences in functional impairment (Robertson and Ireland, 1995; Perez et al., 2001). The use of the subscales (physical, emotional, functional) were derived *a priori* and the subscale structure has been questioned in at least three (Asmundson, Stein, and Ireland, 1999; Perez et al., 2001; Tamber et al., 2009). In fact, based on those reports, the original author along with Asmundson et al. (1999) and Perez et al. (2001) suggested use of only the total score (Asmundson et al., 1999; Perez et al., 2001, Jacobson and Shepard, 2008). The DHI does demonstrate good test-retest reliability and high internal consistency (Jacobson and Newman, 1990; Tamber et al., 2009; Goto et al., 2011). A change in score >18 points has been established as a significant change in function (Jacobson and Newman, 1990). Several studies have evaluated scores on the DHI as outcomes measures in various pathologies including benign paroxysmal positional vertigo (BPPV), unilateral vestibular loss, chronic vestibulopathy, central vestibular system impairment, acoustic neuroma, bilateral vestibular loss, and migraine-related vestibulopathy (Whitney et al., 2005; Brown et al., 2001; Cohen and Kimball, 2003; Humpriss et al., 2003, Jacobson and Newman, 1990; Jacobson and Calder, 2000; Jacobson and McCaslin, 2003; Kinney et al., 1997; Badke et al., 2002; O'Reilly et al., 2000; Murray et al., 2001, Perez et al., 2003, Lynn et al., 1999). The DHI is likely the most widely used questionnaire to measure quality of life in individuals with dizziness or balance disorders.

Vertigo Symptom Scale (VSS). The VSS was developed to focus on symptoms associated with vertigo and to measure the relationship between vertigo, anxiety, and emotional distress in clinical populations (Yardley et al., 1992). Generally speaking, the VSS has demonstrated good reliability, good discriminant validity (Gloor-Juzi et al., 2012), satisfactory internal consistency,

and good test-retest reliability (Wilhelmsen et al., 2008). Greene et al. (2007) demonstrated that the VSS was sensitive to changes over time.

Activities-specific Balance Confidence (ABC) Scale. The ABC Scale was developed by Meyer and Powell (1995) to evaluate specific situations that might affect a patient's perception about imbalance and falls. There is a large body of literature on the use of the ABC Scale in rehabilitation. The scale was normalized on moderate to high functioning (independent) older adults and elderly individuals who described themselves as either having "high" or "low" mobility. Powell and Myers (1995) demonstrated that the scale has good test-retest reliability and an ability to separate high mobility from low mobility individuals based on scores. Talley, Wyman, and Gross (2008) evaluated the psychometric properties of the ABC Scale in older women (community dwelling, >70 years old) and reported a moderate relationship between the ABC score and various measures of physical functioning (e.g. timed-up-and-go and gait speed) as well as history of falling. Talley et al. (2008) reported ceiling effects for less frail participants suggesting this particular tool may not be effective in assessing change over time. No normative data have been established for adults younger than 65 years of age. The ABC Scale may be beneficial for use to assess falls risk. LaJoie and Gallagher (2004) reported using a cut-off score of <67% as a predictor for future falls in individuals with a previous history of falling. The ABC scale is not specific to vertigo or dizziness and primarily focuses on the mobility of elderly individuals. The ABC scale was not necessarily developed for use for those with vestibular disorders; however, the ABC scale has been studied in individuals with unilateral hypo-function (Whitney et al., 2004; Legters et al., 2005) and bilateral vestibular hypo-function (Brown et al., 2009).

Vestibular Disorders of Daily Living (VADL) Scale. The VADL was designed to assess the effects that vertigo and imbalance have on an individual's activities of daily living (Cohen and Kimball, 2000). The VADL has good internal consistency and same day test-retest reliability. No relationship was observed between the VADL scores and vertigo intensity. Weak correlations were established between VADL scores and both vertigo frequency and scores on the Sensory Organization Test (in particular, conditions 5 and 6). Overall, limited data are available for the VADL. For example, reproducibility has not been established and the discriminant value is questionable (Duracinsky et al., 2007).

UCLA Dizziness Questionnaire (UCLA-DQ). The purpose of this scale was to determine the frequency of dizziness, the severity of dizziness, and impact of dizziness on a patient's quality of life and activities of daily living (Honrubia et al., 1996). Honrubia and colleagues demonstrated that greater frequency of dizziness was associated with greater negative impacts on activities of daily of living. Greatest dizziness severity was reported by patients with BPPV, peripheral vertigo, and patients with migraine. Although individuals with BPPV reported greatest dizziness severity, they also reported the least amount of impact on quality of life. Weak correlations have been established between the UCLA-DQ and the Sensory Organization Test; however, the UCLA-DQ is also correlated with perceived handicap on the DHI (Perez et al., 2003). There are limited data on the psychometric properties of the UCLA-DQ as test-retest, structural validity, responsiveness to change, and internal consistency have yet to be evaluated. Lack of information regarding the psychometric properties of the UCLA-DQ makes it less than ideal for clinical use.

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Recommendation 3. Bedside Tests.

The use of bedside tests is not recommended as a replacement for the videonystagmography/ electronystagmography (VNG/ENG) test battery. The following bedside tests, however, may be used to complement the VNG/ENG test battery: modified Clinical Test of Sensory Interaction on Balance; The Romberg test; Valsalva Induced Nystagmus Testing; and Bedside (no goggles) Head Impulse Test. The usefulness of Fukuda stepping, vibration induced nystagmus, hyperventilation test, and head shake nystagmus test is less clear (Grade II).

Strength of Evidence/Recommendation: Grade II

Summary: Bedside tests were originally developed to assess the vestibular system with minimal test equipment and to ascertain the need for further clinical work-up. As such, many of these measures can be thought of as broad screening measures; however, the sensitivity and specificity related to each test can be quite variable for identifying peripheral vestibular loss. Therefore, they should only be used to augment the current test battery and not replace them for assessment. A brief description of common bedside examination and sensitivity and specificity (when available) can be found below. Specifically, a literature review was performed on the clinical usefulness of the following bedside tests: Fukuda Stepping Test, Romberg, Modified Clinical Test of Sensory Organization and Balance, head shake test, head impulse test, hyper-ventilation test, and Valsalva test.

The modified Clinical Test of Sensory Interaction on Balance (mCTSIB) may be a useful complement to the vestibular test battery in clinics where standard posturography (SOT) equipment is not available. The mCTSIB provides information on balance ability in four conditions where either visual cues or support surface information is altered. Patients with vestibular deficits have demonstrated impairments and greater balance difficulty on this test as

well as patients with fall risk (Nashner, 1982; Anacker and DiFabio, 1992; Cohen et al., 1993). Good test-retest and inter-rater reliability have been established (Cohen et al., 1993). Agreement between the sensory organization test results and the mCTSIB results range from 68-100% (DiFabio and Badke, 1990). Therefore, the test may be a good mechanism to determine the need for further falls risk assessment and/or may provide a justification for recommendations related to balance training and rehabilitation.

The Romberg test is primarily a screening test for poor balance and is able to detect difficulties with balance with eyes closed. The test is believed to reflect primarily dorsal column function rather than vestibular dysfunction. Jacobson et al. (2011) conducted a retrospective chart review to determine the predictive value of a Romberg test result (including conducting a Romberg on foam) for peripheral vestibular dysfunction (for horizontal semicircular canal dysfunction/superior nerve function, sensitivity = 55%; specificity = 64%, for saccule/inferior nerve function, sensitivity = 40%, specificity = 50%). Therefore, overall they found that the Romberg was insensitive to vestibular impairment. Black et al. (1989) demonstrated normal function on the Romberg pre and post-vestibular nerve section in 14 patients. Conversely, Herr et al (1989) found that a positive Romberg was significantly correlated with peripheral vestibular pathology in a group of 137 patients presenting to an ER clinic for dizziness. Given the varied performance on the test, the usefulness of the Romberg in a setting evaluating vestibular function is likely confined to a gross measure of balance (not vestibular) function and may be used as a tool for determining the need for additional balance assessment.

Valsalva Induced Nystagmus Testing. Most of the research describing nystagmus evoked by the Valsalva maneuver involved patients with superior semicircular canal dehiscence syndrome (SSCD). In most cases, these studies involve small sample sizes. Sensitivity of the Valsalva maneuver (i.e., eliciting dizziness or nystagmus) in identifying patients with SSCD ranges from 29-100% with an average sensitivity of approximately 82% (Brantberg et al., 2004; Minor et al., 2001; Minor, 2000; Brantberg et al., 2001, Cremer et al., 2000, Hillman et al., 2006, Rambold et al., 2001). In patients complaining of pressure-induced vertigo, recording eye movements with VNG equipment during a Valsalva maneuver along with symptoms may provide additional justification for completion of VEMP testing or for referral for imaging to rule out SSCD when VEMP testing is unavailable.

The Bedside (no goggles) Head Impulse Test (HIT) has most often been used to screen for peripheral vestibular impairment. Studies comparing head impulse testing to caloric testing in those with varying degrees of loss of vestibular function suggest that the sensitivity of the head impulse test increases with degree of vestibular hypofunction. When using the caloric test as the reference test, the bedside HIT has been shown to have a sensitivity of 100% and specificity ranging from 97 to 100% in cases of unilateral vestibular nerve sections (~100% unilateral caloric weakness) (Halmalygi and Curthoys, 1988; Foster et al., 1994; Lehnen et al., 1994). In contrast, studies that included patients with partial vestibular losses (unilateral caloric weaknesses ranging from ~25 to 100%), indicated bedside HIT sensitivities ranging from 34 to 75% (average = 51%) and specificities ranging from 82 to 97% (average = 91%) (Harvey and Wood, 1996; Harvey et al., 1997; Beynon et al.,1998; Perez and Rama-Lopez, 2003; Schubert, et al., 2004). The usefulness of the bedside HIT includes the ability to detect unilateral and bilateral vestibular losses, no equipment cost, short test time, portability, and the ability to assess horizontal SCC function at frequencies of head rotation that are more representative of the head movements that occur during activities of daily living (Grossman et al., 1988; Grossman and Leigh, 1990; Das et al., 1995).

A review of the literature revealed that the clinical utility of the following bedside tests as a supplement to the VNG/ENG test battery is less clear: Fukuda Stepping, Vibration Induced Nystagmus, Hyperventilation Test, and Head Shake Nystagmus testing.

Head shake nystagmus may occur in peripheral or central vestibular lesions and often has been used as a screening technique. Studies have demonstrated variability in the sensitivity of head shake nystagmus with varying degrees of vestibular weakness. In patients with complete unilateral vestibular hypofunction, sensitivity has been reported s 100% and specificity of 43% (Hain et al., 1987). Conversely, in partial vestibular loss, sensitivity ranges from 42% to 90% and specificity ranges from 53 to 85% (Takahasi et al., 1990; Goebel and Garcia, 1992; Fujimoto et al., 1992; Tseng and Chao, 1997; Guidetti et al., 2002; Iwasaki et al., 2004). In general, as the degree of peripheral system loss increases, the sensitivity of the headshake test increases. Given the variability in the test performance and the information obtained during caloric testing, the usefulness of this additional test has yet to be demonstrated when used as an adjunct to the full test battery.

Fukuda Stepping. Originally developed to help identify individuals with peripheral vestibular loss, the sensitivity of this test ranges from 26 to 70% (Moffatt et al., 1989, Norre et al., 1989). Numerous investigators through retrospective chart review and non-randomized prospective studies have demonstrated that Fukuda stepping is a poor tool to detect unilateral peripheral deficit and should not be used as a screening tool (Honaker et al., 2009, Honaker and Shepard, 2012, Zhang and Wang, 2011; Jacobson et al., 2011; Longridge and Mallinson, 2010; Cohen et al., 2014). Further, Jordan (1963) demonstrated significant test retest variability in a group of subjects tested at 2 hour intervals. Given the variable test performance, it is not recommended to include Fukuda Stepping as part of the bedside examination.

Hyperventilation Testing**.** Studies involving hyperventilation induced nystagmus testing were reviewed in a variety of patient populations (vestibular Schwannoma, vestibular neuritis, central vestibular disorders and complete vestibular deficit from acoustic neuroma resection) and control subjects (Monday and Tetreault, 1980; Wilson and Kim, 1981; Bance et al., 1998; Minor et al., 1998; Robichaud et al., 2002; Park et al., 2010; Bradley et al., 2011; Califano et al., 2011). Hyperventilation nystagmus rarely occurs in the normal population (Mandala et al., 2013), Sensitivity of the hyperventilation test to vestibulopathy ranges from 8-100% with specificity ranging from 96-100% (Monday and Tetreault, 1980; Wilson and Kim, 1981; Bance et al., 1998; Minor et al., 1998; Robichaud et al., 2002; Park et al., 2010; Califano et al., 2011). Of note, Califano and colleagues (2011) reported that hyperventilation-induced nystagmus has a higher incidence in retrocochlear pathology than peripheral vestibular end-organ pathology. Specifically, in 1202 patients with dizziness, the incidence of hyperventilation induced nystagmus was 92% for patients with neuromas compared to 5% in BPPV, 37.6% in compensated vestibular neuritis, and 77% in acute vestibular neuritis.

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Recommendation 4. Benign Paroxysmal Positional Vertigo (BPPV)

Perform the Dix-Hallpike maneuver to rule out benign paroxysmal positional vertigo (BPPV) of the posterior or anterior semicircular canals (Grade I).

1. **If the Dix-Hallpike test is positive for posterior canalithiasis, then**
    a. **Treat with canalith repositioning procedure (modified Epley or Semont) (Grade I, *CPT 95992*).**
    b. **Post-treatment restrictions are unnecessary (Grade II).**

2. **If the Dix-Hallpike test is positive for anterior canalithiasis, then treat with canalith repositioning procedure (Grade II, *CPT 95992*).**
3. **If the Dix-Hallpike test is negative, then perform the Roll test to rule out BPPV of the horizontal semicircular canal (Grade II)**
    a. **If BPPV is positive for horizontal canalithiasis, then counsel patient and treat with barbeque roll, Gufoni maneuver or forced prolonged positioning (Grade II, *CPT 95992*).**
4. **If BPPV testing is positive and only symptom is brief motion-provoked vertigo, then**
    a. **No further vestibular testing is necessary (Grade II).**
    b. **Follow-up in 1-2 weeks after treatment with phone call or face-to-face visit (Grade II).**

Summary. A PubMed search revealed over 1000 journal articles on benign paroxysmal positional vertigo (BPPV), including three Cochrane systematic reviews (Hilton and Pinder, 2004, 2010; Hunt et al., 2012) and two practice guidelines (Bhattacharyya et al., 2008; Fife et al., 2008). The practice guidelines were based on evidence-based reviews developed by expert multidisciplinary panels convened by the American Academy of Neurology (Fife et al., 2008) and the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) (Bhattacharyya et al., 2008). The current clinical recommendations are based on a review of the two practice guidelines, Cochrane reviews and several clinical trials published after the practice guidelines.

Both practice guidelines provide a strong recommendation, based on diagnostic studies with minor limitations and a preponderance of benefit over harm, that clinicians should diagnose posterior semicircular canal BPPV when vertigo associated with nystagmus is provoked by the Dix-Hallpike maneuver (Bhattacharyya et al., 2008; Fife et al., 2008). Canalith repositioning procedures (CRP) are recommended strongly as a safe and effective treatment for posterior canal BPPV based on numerous randomized controlled studies (Bhattacharyya et al., 2008; Fife et al., 2008; Hilton and Pinder, 2004, 2010). A recent double-blinded randomized controlled study concluded that the Semont (Liberatory) maneuver was safe and effective in patients with posterior canal BPPV (Chen et al., 2012). Because anterior canal BPPV is uncommon and may be transitory, there are few studies examining the effectiveness of CRP. Several case series, however, have reported high response rates to CRP for anterior canal BPPV (e.g., Casani et al., 2011).

A comparison of randomized controlled studies suggests no differences in outcomes with or without post-treatment restrictions. Several clinical trials have examined the benefit of post-treatment restrictions on treatment of posterior canal BPPV, and all except one found no benefit of postural restrictions following CRP. Based on this evidence, post-treatment restrictions are not recommended.

Bhattacharyya et al. (2008) recommended that clinicians perform the supine roll test to assess for horizontal canal BPPV if a patient presents with BPPV-like symptoms and the Dix-Hallpike is negative. These recommendations are based on observational studies with limitations and a preponderance of benefit over harm. Procedures used to treat horizontal canal include variations of the supine roll maneuver, the forced prolonged positioning, the Gufoni maneuver and the Vannucchi-Asprella Liberatory maneuver. Case series and uncontrolled clinical trials have demonstrated that these treatments are moderately effective for horizontal canal BPPV

(Bhattacharyya et al., 2008). A recent double-blinded randomized controlled trial suggests that the Gufoni maneuver is effective for geotropic BPPV (Mandala et al., 2013).

Based on diagnostic and observational studies and a preponderance of benefit over harm, the AAO-HNS panel recommended that clinicians should not obtain vestibular testing in a patient diagnosed with BPPV unless the diagnosis is uncertain or there are additional symptoms or signs unrelated to BPPV that warrant testing (Bhattacharyya et al., 2008). The panel also recommended that clinicians follow up with patients within one month after treatment to confirm symptom resolution, and this recommendation is based on observational outcome studies, expert opinion, and a preponderance of benefit over harm.

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Recommendation 5: Videonystagmography/Electronystagmography

Perform VNG or ENG test battery.

5b. At a minimum, the VNG/ENG test battery should include the following ocular motor tests: smooth pursuit, saccade, eccentric gaze tests and search for spontaneous nystagmus.

Strength of Evidence/Recommendation: Grade II

5c.Testing may also include optokinetic nystagmus, search for positional nystagmus, and fixation suppression.

Strength of Evidence/Recommendation: Grade III

Summary. A total of 75 articles were reviewed. Of those articles, the majority were case-control and case report/series (31%). In addition, expert opinions/review articles were also the most common types of evidence found (26%). No meta-analysis/systematic reviews were obtained from the search and limited controlled trials were identified (< 1%). Based on this review, the evidence base for making the recommendation to include ocular motor testing, spontaneous/ positional nystagmus, and fixation suppression tests into the VNG/ENG test battery are weak. Clinical practice guidelines were found to support the use of electronystagmography testing (Furman et al., 1996; Fife et al., 2000) and these reports covered the broad topic of ocular motor testing and positional testing; however, specific reference to the subtests were limited in these reports. It should be noted that all guidelines recommended VNG/ENG testing for the evaluation of patients with dizziness and imbalance and noted that this is a safe evaluation.

Assessment of the ocular motor systems provides information about central nervous system (CNS) function independent of the peripheral vestibular system. Ocular motor systems that contribute to control of eye movement include: saccades, smooth pursuit, gaze stability testing, and optokinetic nystagmus. There is substantial evidence in the literature to support the use of these ocular motor system tests to identify CNS dysfunction (Zee et al., 1976; Yee et al., 1976; Metz, 1976; Troost et al., 1976; Takemori et al., 1978; Mastaglia et al., 1979; Crane et al., 1983; Leigh et al., 1983; Metz, 1983; White et al., 1983; Meienberg et al., 1986; Steenerson et al., 1986; Fletcher and Sharpe, 1988; Moschner et al., 1994; Stipkovits et al., 1999; Van der Torn and Van Dijk, 2000; Takeshi et al., 2001; Serra et al., 2003; Pawlak-Osinska et al., 2005). The majority of the articles supported the use of laboratory electro-oculography (EOG) to better detect saccade, smooth pursuit, gaze stability, and optokinetic nystagmus abnormalities. The laboratory EOG, as part of ENG assessment, is essential for detecting subclinical disorders.

The ocular motor tests, when incorporated in VNG/ENG, aid in identifying central causes and differentiating central from peripheral lesions. They are sensitive and specific indicators of brainstem, cerebellar dysfunction and can provide precision in diagnostic confirmation; however, MRI (while not the more cost-effective option), is still the superior sensitive measure (Tedeschi et al., 2013). The use of optokinetic nystagmus testing as part of the ENG test battery is questionable (Kveton et al., 1999), as the stimulus needs to be approximately 80-90% full field in order to elicit a circularvection response (Leigh and Zee, 2006). The test is recommended as part of the rotational chair examination to allow for the appropriate full-field stimulus (Shepard and Schubert, 2008).

Expert opinions and selected guidelines suggested the use of spontaneous and positional nystagmus tests in the VNG/ENG assessment (Ruckenstein, 2000; Eggers, 2003; Brant et al., 2005; Shepard, 2007); however, the literature reports the non-localizing nature of these findings and recommends correlation with clinical signs and case history for rendering a diagnosis (Steenerson, 1986; Lambert, 1986; Lin et al., 1986; Slattery et al., 2001). Failure of fixation suppression test was the least supported assessment measure in the literature. There are numerous limitations with the test (inter-rater reliability, age and gender of the patient) that contribute to the poor sensitivity/specificity (Jacobson et al., 1993; Schuchman and Uri, 1986; Katsarkas and Kirkham, 1982).

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5d. Perform the caloric test (air or water) to identify a horizontal semicircular canal/superior vestibular nerve lesion.

Strength of Evidence/Recommendation: Grade II

Summary. The caloric test is the most common method used to stimulate the vestibular system for clinical assessment. The main advantage of the caloric test is the ability to lateralize a vestibular deficit by stimulating each ear independently and it is generally considered the 'gold standard' test of horizontal semicircular function, especially for the identification of unilateral vestibular losses (e.g., Herdman et al., 1998). Caloric testing has been established as an effective testing technique based on controlled studies and by expert consensus (Fife et al., 2000).

Although a few studies have suggested that water irrigation is more reliable than air (e.g., Coats et al., 1976; Zangemeister and Bock, 1980), most studies have demonstrated that either type of irrigation provides an adequate and reliable caloric stimulation (e.g., Suter et al., 1977; Ford and

Stockwell, 1978; Karlsen et al., 1992, Zapala et al., 2008; Maes et al., 2007). Several studies have suggested that adequate air irrigation is dependent on careful irrigator tip placement (Torok, 1979, Suter et al., 1977; Proctor, 1977). Currently, there are only American National Standards Institute (ANSI) standards for recording parameters (temperature, duration, flow rate/volume) for water and not for air irrigations (ANSI 2009).

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5e. Consider monothermal warm caloric screening when the following criteria exist: (1) total slow phase eye velocities for warm calorics > 11 degrees/sec, (2) no spontaneous or positional nystagmus, and (3) no ocular motor abnormalities. If the inter-ear difference for warm caloric screening is asymmetrical (> 10%) or if other criterion is not met, then bithermal calorics should be administered *(CPT 92543 each irrigation*).

Strength of Evidence/Recommendation: Grade II

Summary. The caloric test is a time consuming part of the VNG battery and is sometimes not tolerated well by patients. Monothermal caloric screening has been investigated as a way to reduce test time and patient discomfort but not compromise the quality of care (e.g., Barber et al., 1971; Murnane et al., 2009; Lightfoot et al., 2009; Shupak et al., 2010; Bush et al., 2013). Several large retrospective studies have demonstrated low false-negative rates ranging from 2 to 6% using an inter-ear difference cut off for monothermal caloric screening of 5 to 15% (Longridge and Leatherdale, 1980; Norré, 1987; Enticott et al., 2003; Murnane et al., 2009). Most studies have shown a higher sensitivity for monothermal warm caloric screening compared to monothermal cold caloric screening (Jacobson et al., 1995; Enticott et al., 2003; Lightfoot et al., 2009; Murnane et al., 2009; Shupak et al., 2010). Several authors have suggested supplemental failure criteria with the use of a higher inter-ear difference (Jacobson et al. 1995; Enticott et al., 2003), although it is likely that additional failure criteria are unnecessary if a low inter-ear difference (e.g., 10%) is used as the cutoff point (Enticott et al., 2003; Murnane et al., 2009).

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5f(i): If VNG/ENG test findings are normal, and Dizziness Handicap Inventory (or other quality of life questionnaire) indicates minimal balance handicap, then discharge patient back to referring provider.

Strength of Evidence/Recommendation: Grade III

Summary. For physicians, the evaluation of dizziness can be challenging due to a wide range of potential etiologies. The goal for the physician is to determine etiology and treat/manage the patient. To do this, additional specialist testing is often ordered. The role of the audiologist as

described by the American Speech Language Hearing Association (ASHA) in the assessment and management of the dizzy patient includes (a) administering VNG/ENG test battery, rotational testing (and other clinical tests as appropriate), (b) interpreting and integrating all test results with patient history, symptoms and pertinent information and (c) determining appropriate candidacy for vestibular and balance rehabilitation (ASHA, 1992; ASHA, 1999). In cases, where normal peripheral vestibular function has been established and minimal handicap is reported, general consensus/ long-standing practice would suggest that patients be discharged back to the referring physician for further work-up outside the scope of practice of audiology.

A review of the literature produced no studies evaluating outcomes and or management practices of individuals with normal vestibular function and minimal handicap. This current recommendation is based on long standing practice without substantial supporting basic or clinical data.

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5f(ii): If VNG/ENG test findings are normal, and Dizziness Handicap Inventory (or other quality of life questionnaire) indicates significant balance handicap, then refer for balance and gait assessment (e.g., computerized dynamic posturography) including fall risk.

Strength of Evidence/Recommendation: Grade II

Summary. Forty-three studies were reviewed and reflect meta-analyses, systematic reviews, cohort studies, observational studies, longitudinal studies, and cross-sectional studies.

Falls risk assessment is an important referral consideration for patients with dizziness and imbalance. Nevitt, Cummings and Hudes (1991) demonstrated that both significant injury (fractures, dislocations, and open wounds requiring sutures) and soft tissue injury were common in elderly individuals who fall. Several meta analyses and systematic reviews are available on the topic of injuries and injury prevention in patients that fall (for further readings, see Chang et al., 2004; Costello and Edelstein, 2008; Gates et al., 2008; Gillespie et al., 2012; McClure et al., 2005; Michael et al., 2010; Muir et al., 2012; Robertson et al., 2002; Weatherall, 2004). In patients who have normal vestibular test results, careful review of self-reported handicap and case history indices are important to provide appropriate referrals.

Research studies have attempted to compare subjective scores of disability and handicap to measures of balance and falls risk prediction. Results to date have been mixed. For the Dizziness Handicap Inventory (DHI), some studies found individuals with higher scores have shown greater functional impairment (Loughran et al., 2006; Perez, Martin, and Garcia-Tapia, 2003; Vereeck et al., 2007; Whitney, 2004) while other studies report no differences in functional impairment (Hansson et al., 2005; Perez et al., 2001; Robertson and Ireland, 1995). Vereeck et al. (2007) noted that when evaluating functional impairments, the DHI correlated best with balance tests involving locomotion rather than static balance assessments. The Activities-specific Balance Confidence Scale (ABC Scale) was developed to evaluate specific situations that might affect a patient's perception about imbalance and falls (Powell and Myers, 1995). In contrast to the DHI, a relationship between the ABC score and falls risk is well

established. The vast majority of studies utilizing the ABC scale have demonstrated that the ABC score is predictive for falls and can discriminate fallers from non-fallers (Beauchamp et al., 2009; Lajoie et al., 2002; Lajoie et al., 2004; Moore et al., 2011; Powell and Myer, 1995; Whitney et al., 2006). Additionally, studies have demonstrated that higher ABC scores were related to better mobility and balance performance (Beauchamp et al., 2009; Brouwer et al., 2004; Lajoie et al., 2002; Lajoie et al., 2004; Marchetti et al., 2011; Moore et al., 2011; Portegijs et al., 2012; Powell and Myers, 1995; Whitney et al., 2006). Lajoie et al. (2004) reported that scores less than 67% could correctly classify someone at risk for falling with 84% sensitivity and 87% specificity. Conversely, Hotchkiss et al. (2004) found that ABC scores were not predictive for falling in a cohort of individuals over the age of 60. While Hotchkiss and colleagues did not find the ABC scale to be predictive of falls, the vast majority of the evidence suggests that in older adults, the ABC scale may be a quick and efficient measure of falls risk.

Additionally, risk factors for falling have been studied extensively (Chang et al., 2004; Deandrea et al., 2010; Vieira et al., 2011). Several meta-analysis and systematic reviews have identified factors that increase an individual's risk for falling (Deandrea et al., 2010; Muir et al., 2012; Thurman et al., 2008; Vieira et al., 2011) across studies. A positive history of falling is consistently identified as increasing an individual's falls risk (Deandrea et al., 2010; Friedman et al., 2002; Gassmann et al., 2009; O'Loughlin et al., 1992; Stalenhoef et al., 2002; Tinetti et al., 1988, Vieira et al., 2011;). Other important falls risk factors include increasing age (Friedman et al., 2002; Gassmann et al., 2009; Vieira et al., 2011), dizziness/vertigo/imbalance/gait difficulties (Campbell et al., 1989; Deandrea et al., 2010; Gassmann et al., 2009; O'Loughlin et al., 1992; Tinetti et al., 1988), cognitive impairment (Gassmann et al., 2009; Muir et al., 2012; Tinetti et al., 1988; Vieira et al., 2011), medication use/polypharmacy (Campbell et al., 1989; Deandrea et al., 2010; Friedman et al., 2002; Hartikainen et al., 2007; O'Loughlin et al., 1992; Tinetti et al., 1988; Vieira et al., 2011), chronic health conditions(Campbell et al., 1989; Friedman et al., 2002; Gassmann et al., 2009; Richardson and Hurvitz, 1994; O'Loughlin et al., 1992; Stalenhoef et al., 2002; Vieira et al., 2011), orthostatic hypotension (Campbell et al., 1989; Deandrea et al., 2010; O'Loughlin et al., 1992; Tinetti et al., 1988; Gassman et al., 2009; Vieira et al., 2011) and reduced or poor vision (Desapriya et al., 2010; Boutin et al., 2012; Salonen and Kivela, 2012). When these risk factors are identified, a referral for falls risk assessment may be warranted.

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5g(i): If VNG/ENG test findings indicate unilateral vestibular loss, then consider computerized dynamic posturography.

Strength of Evidence/Recommendation: Grade II

Summary. Early reports in the literature (retrospective reviews, cross-sectional data) support the use of computerized dynamic posturography (CDP) for documenting functional balance deficits (functionally uncompensated for maintenance of stance) secondary to peripheral vestibular dysfunction (paresis); however, the majority of the articles reviewed demonstrated poor sensitivity for identifying abnormal peripheral vestibular disorders and had relatively small sample sizes. While not particularly included for this review, a number of articles supported CDP as outcome measure post-vestibular rehabilitation for patients with unilateral and bilateral peripheral vestibular loss; evidence supports use of pre-therapy CDP measures to document functional ability to maintain upright stance under changing sensory conditions. Strongest supporting evidence is found in expert opinion articles/review articles (Furman, 1994, 1995; Ruckenstein and Shepard, 2000) and textbooks (Shepard and Telian, 1996; Jacobson and Shepard, 2008).

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5g(ii): If VNG/ENG test findings indicate unilateral vestibular loss and the hearing evaluation indicates an asymmetric sensorineural hearing loss, then consider referral for auditory brainstem response (ABR) and/or magnetic resonance imaging (MRI) to rule out retrocochlear pathology.

Strength of Evidence/Recommendation: Grade II

Summary. Ten articles were reviewed, and five were retrospective studies that examined the sensitivity of the caloric test for retrocochlear pathology (e.g., vestibular schwannoma). Approximately 80% of patients with vestibular schwannoma have a unilateral caloric weakness (Linthicum and Churchill, 1968; Harner and Laws, 1983; Ushio et al., 2009), and several studies demonstrated that unilateral caloric weakness correlates with tumor size (Linthicum and Churchill, 1968; Kentala and Pyykko, 2001; Tringali et al., 2010). An abnormal auditory brainstem response (ABR) and asymmetric hearing loss are more predictive test findings for vestibular schwannoma than a unilateral caloric weakness (Ushio et al., 2009; Saliba et al., 2009). Saliba et al. (2009) propose the “rule 3000” based on a review of audiovestibular test results in 121 patients examined for vestibular schwannoma. They found that an asymmetric SNHL of 15 dB or more at the frequency 3,000 Hz was the most predictive audiovestibular test finding for vestibular schwannoma, and the addition of a unilateral weakness did not help in predicting the presence of a vestibular schwannoma. Based on these studies, we recommend that audiologists obtain a hearing evaluation on patients with unilateral caloric weakness, and refer patients with an asymmetric sensorineural hearing loss (rather than caloric weakness alone) for ABR and/or magnetic resonance imaging (MRI) to rule out vestibular schwannoma.

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Recommendation 5g(iii): If VNG/ENG test findings indicate unilateral vestibular loss, then consider medical referral (e.g., otolaryngology, neurology).

Strength of Evidence/Recommendation: Grade II

Summary. The vestibular laboratory finding of unilateral weakness is suggestive of damage to the peripheral vestibular system (labyrinth, vestibular nerve or root entry zone of the vestibular nerve) on the side of the weakness. The possible causes of unilateral vestibular loss include Ménière's disease, vestibular neuritis, labyrinthitis, autoimmune disease, cerebrovascular disease and vestibular shwannoma (e.g., Enander and Stahle, 1969; Black and Kitch, 1980; Oosterveld, 1980; Park et al., 2005; Lachman and Stahle, 1967; Bergenius and Borg, 1983; Strupp and Brandt, 2009; Lin and Young, 2011; Jeong et al., 2013; Jung et al., 2012; Kim et al., 2011; Braun et al., 2011; Lee, 2012; Su and Young, 2011; Ylikoski et al., 1980; Harner and Laws, 1983; Linthicum and Churchill, 1968; Ushio et al., 2009). Based on this evidence, it is recommended that clinicians consider a referral to otolaryngology or neurology for diagnosis and medical management of vestibular pathology.

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Recommendation 5g(iv): If VNG/ENG test findings indicate unilateral vestibular loss, and Dizziness Handicap Inventory (or other quality of life questionnaire) indicates significant balance handicap, then recommend vestibular rehabilitation.

Strength of Evidence/Recommendation: Grade I

Summary. A PubMed search revealed 370 articles on vestibular rehabilitation including two Cochrane database systematic reviews on the effectiveness of vestibular rehabilitation on individuals with unilateral vestibular loss (UVL). In the most recent review, Hillier and McDonnell (2011) examined 27 clinical trials (1668 participants) that investigated the effectiveness of vestibular rehabilitation versus control or sham interventions, medical interventions or other types of vestibular rehabilitation. Individual and collective data showed that vestibular rehabilitation is effective over control or no interventions in individuals with UVL. In summary, there is moderate to strong evidence that VR is safe, effective management for UVL based on a number of high-quality randomized controlled trials.

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Recommendation 5h(i): If VNG/ENG test findings indicate bilateral vestibular loss, then rule out the effect of medications.

Strength of Evidence/Recommendation: Grade II

Summary. A total of 18 articles and one book chapter were reviewed. The majority of the articles were case-control and case report (89%). Four of the case-control articles were based on animal research, whereas the other 12 were completed on human subjects. Two systematic reviews, including the book chapter, were also obtained from the search (11%).

Based on this review, there is strong evidence for considering pharmacologic influence when performing vestibular diagnostic testing. Substantial evidence was provided in the literature to support that certain medications, such as meclizine and benzodiazapines (particularly lorazepam and diazepam), negatively affect the vestibulo-ocular reflex as related to caloric and rotational testing (Gutner et al., 1956; Martin and Oosterveld, 1970; Sekitani et al., 1971; Ryu and McCabe, 1974; Blair and Gavin, 1979; Padoan et al., 1990; Cass and Furman, 1993; Leigh and Zee, 2006; Morrow and Young 2007; Weerts et al., 2012). Dimenhydrinate (Dramamine) also has been shown to decrease VOR function (Gutner et al., 1951; Collins et al., 1982).

The literature also indicated that other medications including promethazine hydrochloride (antihistamine), mirtazapine, baclofen, phenytoin, phenobarbital/barbiturates, alcohol, fentanyl,

and scopolamine can reduce vestibular function during caloric and rotational testing (Cass and Furman, 1993; Leigh and Zee, 2006; Knox et al., 1994; Mai et al., 1986; Morrow and Young, 2007; Weerts et al., 2012).

Considering the established effects of these medications on the vestibulo-ocular reflex, it should be recommended that patient refrain from these medications prior to performing vestibular assessment. However, if patient is unable to refrain from the medications, then results should be interpreted with caution. Also, Cass and Furman (1993) suggests that it is critical to maintain alertness in patients who have taken medications that are capable of producing labyrinthine hypofunction.

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Recommendation 5h(ii): If VNG/ENG test findings indicate bilateral vestibular loss, then perform or refer for rotational testing if available.

Strength of Evidence/Recommendation: Grade II

Summary. Numerous reports have indicated that the bithermal caloric test can yield false positive results for bilateral vestibular loss (e.g., Baloh et al., 1984; Furman and Kamerer, 1989; Myers, 1992; Hain, 2013). The poor sensitivity for bilateral vestibular loss (BVL) may be due to the wide variability of caloric responses in normal individuals, and reduced responsiveness to caloric stimulation may be related to size and shape of external auditory canals, thickness of the temporal bones, or poor alertness.

Rotary chair testing has been used as a method for diagnosing BVL (e.g., Baloh et al., 1984; Sargent et al., 1997; Gillespie and Minor, 1999; Guinand et al., 2012), and decreased gain on low frequency sinusoidal rotation (<0.04 Hz) is often considered the gold standard for BVL (Furman and Kamerer, 1989; Hain, 2013; Jen, 2009; Fife et al., 2000). Because rotary chair assesses vestibulo-ocular reflex function over a broader physiologic range than calorics, the test provides a quantitative method for determining the severity of BVL (Telian et al., 1991; Myers, 1992). Gilespie and Minor (1999) have suggested that the presence or absence of residual vestibular function may have prognostic implications.

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Recommendation 5h(iii): If VNG/ENG test findings indicate bilateral vestibular loss, then consider computerized dynamic posturography.

Strength of Evidence/Recommendation: Grade II

Summary. Early reports in the literature (retrospective reviews, cross-sectional data) support the use of computerized dynamic posturography (CDP) for documenting functional balance deficits (functionally uncompensated for maintenance of stance) secondary to peripheral vestibular dysfunction (paresis); however, the majority of the articles reviewed demonstrated poor sensitivity for identifying abnormal peripheral vestibular disorders and had relatively small sample sizes. Fall reactions and increased body sway are predicted on CDP, Sensory Organization Test conditions 5 and 6 and this is supported with evidence from the literature. While not particularly included for this review, a number of articles scanned supported CDP as outcome measure post-vestibular rehabilitation for patients with unilateral and bilateral peripheral vestibular loss; evidence supports use of pre-therapy CDP measures to document functional ability to maintain upright stance under changing sensory conditions. The strongest supporting evidence was found in expert opinion articles/ review articles (Furman 1994, 1995; Ruckenstein and Shepard, 2000) and textbooks (Shepard and Telian, 1996; Jacobson and Shepard, 2008).

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Recommendation 5h(iv): If VNG/ENG test findings indicate bilateral vestibular loss, then consider medical referral (e.g., otolaryngology, neurology).

Strength of Evidence/Recommendation: Grade II

Summary. The vestibular laboratory finding of bilateral weakness is suggestive of bilateral vestibular loss (BVL) or damage to both peripheral vestibular labyrinths or to eighth nerves. Although the cause is often idiopathic, BVL can be associated with vestibulotoxicity, meningitis, bilateral Ménière's disease, neurodegeneration, autoimmune disease, head trauma, genetic, cerebrovascular disease, bilateral vestibular shwannomas, and cerebellar dysfunction (e.g., Telian et al., 1991; Baloh et al., 1994; Vibert et al., 1995; Sargent et al., 1997; Syms and House, 1997; Minor, 1998; Rinne et al., 1998; Jen et al., 2004; Zingler et al., 2007; Jen, 2009; Lee et al., 2011; Fujimoto et al., 2012; Hain et al., 2013). Based on this evidence, it is recommended that clinicians consider a referral to otolaryngology or neurology for further evaluation of the potential etiology of the BVL.

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Recommendation 5h(v): If VNG/ENG test findings indicate bilateral vestibular loss, and patient reports significant symptoms of imbalance, then recommend vestibular rehabilitation.

Strength of Evidence/Recommendation: Grade II

Summary. Four articles were reviewed that examined vestibular rehabilitation in patients with bilateral vestibular loss (BVL). Two retrospective case series found that vestibular rehabilitation provided partial improvement in postural stability or symptoms in many patients with BVL although the risk of falling did not change (Bittar et al., 2004; Brown et al., 2001). In a small double-blind, controlled trial Krebs et al. (1993) found that vestibular rehabilitation improved postural stability in patients with BVL but did not improve the perception of dizziness handicap. Porciuncula et al. (2012) reviewed 14 studies examining the effectiveness for vestibular rehabilitation in patients with BVL and determined moderate evidence that vestibular rehabilitation is effective for improving gaze and postural stability in patients with BVL. In summary, the evidence suggests that vestibular rehabilitation may be useful and effective for individuals with BVL.

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Recommendation 5i(ii): If the VNG/ENG test findings indicate ocular motor abnormalities, then rule out the effect of medications.

Strength of Evidence/Recommendation: Grade II

Summary. A total of 33 publications were reviewed. The majority of the articles were case-control and case report/series (94%). Two systematic reviews, including a book chapter, were also obtained from the search (6%).

Most ocular motor effects noted in the case control studies were dose-dependent (Green et al., 2000; Reilly et al., 2008; Rothenberg et al., 1981; Rothenberg and Selkoe, 1981).

Saccades can be affected by numerous medications. Benzodiazepine may cause decreased saccadic peak velocity, and reduced accuracy (mainly undershoot). Carbamazepine may cause decreased saccadic peak velocity, increased latency, and reduced amplitude. Phenytoin significantly reduces saccade latency. Phenobarbital is associated with decreased saccadic peak velocity, increased latency, and reduced amplitude. Thiopental may cause decreased saccadic peak velocity, and increased latency. Secobarbital can produce disruptions of smooth pursuit eye movements and hypermetria noted. Haloperidol is associated with decreased saccadic peak velocity. Amylobarbitone can cause decreased velocity. Alcohol may cause decreased saccade velocity and increased latency. Methadone/narcotics use may result in saccadic undershoot and increased latency. Risperidone is associated with decreased velocity, poor accuracy, and increased latency.

Medications the affect smooth pursuit are also numerous. Decreased pursuit velocity (which requires catch-up saccades) has been associated with Benzodiazepine, Phenytoin, Phenobarbital, Amylobarbitone, and Alcohol. Carbamazepine, Secobarbital, Thiopental, and Methadone/narcotics have been associated with reduced smooth pursuit gain. Chloral hydrate may cause disrupted smooth pursuit eye movements, and tobacco/nicotine have been associated with square wave jerks during smooth pursuit.

Optokinetic nystagmus (OKN) can be affected by the following medications by Dimenhydrinate (Dramamine) and promethazine hydrochloride (antihistamine) which significantly reduces OKN slow phase velocity. Oxazepam can impair attention and affect OKN gain.

Gaze nystagmus can be caused by Phenytoin, Carbamazepine, Phenobarbital, Lithium carbonate, alcohol, and nicotine.

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Recommendation 5i(ii): If the VNG/ENG test findings indicate ocular motor abnormalities, then consider medical referral (e.g., neurology, ophthalmology).

Strength of Evidence/Recommendation: Grade II

Summary. There is substantial evidence that ocular motor abnormalities are associated with central nervous system (CNS) dysfunction, particularly brainstem and cerebellar disorders (e.g., Zee et al., 1976; Yee et al., 1976; Metz, 1976; Troost et al., 1976; Takemori et al., 1978; Mastaglia et al., 1979; Crane et al., 1983; Leigh et al., 1983; Metz, 1983; White et al., 1983;

Meienberg et al., 1986; Steenerson et al., 1986; Fletcher and Sharpe, 1988; Moschner et al., 1994; Stipkovits et al., 1999; Van der Torn and Van Dijk, 2000; Takeshi et al., 2001; Serra et al., 2003; Pawlak-Osinska et al., 2005). Based on this evidence, it is recommended that clinicians consider a referral to neurology or ophthalmology to rule out CNS dysfunction in patients with ocular motor abnormalities.

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Recommendation 6: Cervical vestibular evoked myogenic potentials (cVEMPs)

6a. Consider cervical vestibular evoked myogenic potentials in individuals with a history of dizziness or imbalance related to head trauma or blast exposure.

Strength of Evidence/Recommendation: Grade II

Summary. Recent observations in the military have shown that battlefield related noise (blast exposure) can cause mild traumatic brain injury (mTBI) with associated balance disorders characterized by vertigo, dizziness, and postural instability (e.g., Akin and Murnane, 2011; Scherer and Schubert, 2009). These findings are relevant for VA as mTBI has been called the signature condition of veterans returning from Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) and hearing loss, often related to military noise exposure, is the most common service-connected disability in Veterans. Numerous studies have provided significant evidence that mTBI or head injury can cause damage to the vestibular system (e.g., Barber, 1964; Toglia et al., 1970; van Campen et al., 1999) and specifically, the otolith organs (Kerr and Bryne, 1975; Scherer et al., 2007; Davies and Luxon, 1995). Ernst et al. (2005) provided evidence that otolithic involvement is a common sequela of head trauma by demonstrating a high incidence of cervical vestibular evoked myogenic potential (cVEMP) and subjective visual vertical (SVV) abnormalities (otolith dysfunction) in patients with head injury. Furthermore, Basta et al. (2005) determined that postural stability was correlated with otolith disturbances in patients with mTBI.

The effects of noise on hearing are well known, with noise overstimulation having the potential to cause temporary (reversible) or permanent damage to sensory cells (hair cells) in the cochlea, resulting in temporary or permanent loss of hearing. Less known and considerably less understood is the effect of noise on vestibular and balance function. Early histological studies in humans and animals suggested that the saccule may be particularly susceptible to noise-related damage (McCabe and Lawrence, 1958; Mangabeira-Albernaz et al., 1959). More recent animal studies have also shown that noise overstimulation has its greatest influence on the vestibular end-organ closest to cochlea, the saccule (Fetoni et al., 2009; Akdogan et al.,

2009) and that oxidative stress, caused by noise exposure, induces sensory cell death in the vestibular as well as the auditory systems via similar biochemical pathways (Tamura et al., 2012). The battery of vestibular laboratory tests commonly used to identify vestibular loss in humans (e.g., caloric and rotary chair tests) does not detect saccular dysfunction. The cervical vestibular evoked myogenic potential (cVEMP), however, has been shown to be specific to saccular/inferior vestibular nerve function. Hsu et al. (2008) showed cVEMP threshold increases in guinea pig following noise exposure that were correlated with tissue damage in the saccule. Consistent with animal studies, prospective and prospective case-control human studies have reported cVEMP (saccular) abnormalities in 62 of 125 (50%) patients with noise-induced hearing loss (NIHL) (Wang et al., 2006; Wang and Young, 2007; Wu and Young, 2009; Akin et al., 2012; Tseng and Young, 2013). Zuniga et al. (2012) described a cohort of 51 individuals aged 70 years or older in which there were significant negative correlations between the magnitude of high frequency sensorineural hearing loss and cVEMP amplitude and between the presence of NIHL and cVEMP amplitude.

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Recommendation 6b: Consider cervical vestibular evoked myogenic potentials in individuals with bilateral vestibular loss.

Strength of Evidence/Recommendation: Grade II

Summary. The diagnosis of bilateral vestibular loss (BVL) is typically based on horizontal semicircular canal/superior vestibular nerve dysfunction as assessed by videonystagmography (calorics) and rotary chair tests. Early case reports indicated that saccular/inferior vestibular nerve function (as measured by cervical vestibular evoked myogenic potentials or cVEMPs) can also be affected in patients with BVL (Matsuzaki and Murofushi, 2001; Fujimoto et al., 2005). Subsequent prospective and prospective case-control studies indicated abnormal cVEMPs in 46% to 61% of patients with BVL (Guinand et al., 2012; Agrawal et al., 2013a, 2013b). Zingler et al. (2008) reported significantly lower cVEMP amplitudes in 84 BVL patients compared to 47 healthy controls; cVEMPs were absent unilaterally in 4 BVL patients and no BVL patients had absent cVEMPs bilaterally. Guinand et al. (2012) found no significant difference between BVL patients with present cVEMPs and BVL patients with absent cVEMPs on the following questionnaires: Short-Form Health Survey (SF-36), the Dizziness Handicap Inventory (DHI), and oscillopsia severity, suggesting that there was no additional functional impact of saccular dysfunction on BVL patients. In contrast, Agrawal et al. (2013a, 2013b) reported a significant association between cVEMP amplitude and DHI scores in patients with BVL. In a retrospective case-control study of 29 patients with BVL, Fujimoto et al. (2013) observed that none of the BVL

patients with reduced/absent calorics and normal cVEMPs fell during the eyes-closed condition on foam posturography, whereas 31% of the BVL patients with reduced/absent calorics and absent cVEMPs required assistance to prevent falling. These results suggest that the assessment of otolith (saccular) function, in addition to horizontal canal function, may have prognostic and treatment implications for patients with BVL.

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Recommendation 6c: Consider cervical vestibular evoked myogenic potentials in individuals with symptoms or audiometric findings consistent with superior semicircular canal dehiscence.

Strength of Evidence/Recommendation: Grade II

Summary. Sound and/or pressure-induced vertigo due to dehiscence of the bone overlying the superior semicircular canal was first described by Minor and colleagues in 1998. The clinical signs and symptoms of superior semicircular canal dehiscence (SSCD) may include imbalance, oscillopsia, conductive hyperacusis, sound and/or pressure-induced eye movements, audiometric air-bone gap with preserved acoustic reflexes, and low-threshold cVEMP. The diagnostic utility of cVEMP thresholds occurring at abnormally low stimulus levels in patients with SCD has been described in numerous studies (e.g., Brantberg et al., 1999; Brantberg et al., 2004; Halmagyi, et al., 2003; Minor, 2005; Struebel et al., 2001). At least four subsequent studies (3 retrospective and 1 prospective case-control) have used the results of high resolution CT scans and/or surgery as the gold standard to estimate the sensitivity and specificity of cVEMP threshold in the diagnosis of SSCD (Zhou et al., 2007; Crane et al., 2008; Roditi et al., 2009; Zuniga et al., 2012). Specifically, sensitivity ranged from 67 to 91% and specificity ranged from 80 to 96% using both click and low-frequency tone burst stimuli and cut-off values for cVEMP threshold that ranged from 65 to 85 dB nHL.

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Recommendation 7: Patient Counseling

Clinicians should counsel patients regarding vestibular test findings.

Strength of Evidence/Recommendation: Grade III

Summary. There is very little literature on counseling dizzy patients. In a review article, Bronstein and Lempert (2010) recommend “provision of information, counselling and reassurance” as a component of managing patients with dizziness or vertigo and suggest explaining the principles of vestibular compensation and rehabilitation. The authors suggest that this type of counseling/education motivates patients and actively engages them in the rehabilitation process. In developing the vertigo handicap questionnaire, Yardley and Putnam (1992) found that patient distress is only indirectly related to symptom severity and frequency, and the authors suggest that patients may benefit from counseling and behavioral therapy whether or not vertigo can be controlled. Similarly, in their textbook on counseling in the field of Audiology, Clark and English (2004) mention that the audiologist should help the patients with balance problems that cannot be managed to recognize the resultant limitations and protective measures to prevent injuries. In the BPPV practice guidelines developed by the American

Academy of Otolaryngology-Head and Neck Surgery, the expert panel made a recommendation that clinicians should counsel patients regarding the impact of BPPV on their safety (i.e., increased risk of falls), the potential for recurrence of BPPV, and the importance of follow-up (Bhattacharyya et al., 2008). In summary, because there is little evidence to suggest patients benefit from counseling on vestibular test findings, the recommendation is made because counseling may be useful and is not harmful.

References

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